SHORT REPORTS

Djadjiling Rockshelter: 35,000 ^{14}C Years of Aboriginal Occupation in the Pilbara, Western Australia

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Introduction

The Pleistocene settlement of the arid zone is a prominent research theme in Australian archaeology (Hiscock 2008:45-62; Hiscock and Wallis 2004; Marwick 2002a, 2002b; O'Connor *et al.* 1998; Smith 1987, 2005; Thorley 1998; Veth 1993, 1995, 2005). Of particular interest is the inland Pilbara region of the western arid zone, which until recently was reported to have been first occupied between c.20,000 BP and c.26,000 BP (Brown 1987:27; Edwards and Murphy 2003:45; Maynard 1980:7). The recent test excavations at Juukan-1 rockshelter suggest the region was occupied before 32,920±270 BP (Slack *et al.* 2009:34). Our research at Djadjiling rockshelter supports this result by demonstrating an Aboriginal presence at the site c.35,000 years ago. Not only is the site unique for its antiquity, but excavations have recovered a large flaked stone assemblage from the earliest occupational phase. The evidence demonstrates repeated early site use, and a sequence of intermittent occupation throughout the late Pleistocene and Holocene. The preliminary findings are presented below.

Djadjiling Rockshelter

Djadjiling rockshelter is located c.75km northwest of Newman on the Hamersley Plateau in the Pilbara region of Western Australia. The Pilbara is a biogeographic region within the Australian arid zone, which is defined as receiving less than 350mm of annual rainfall (Bureau of Meteorology 2005). Djadjiling rockshelter is in the traditional lands of the Martidja Banyjima people, who named the site to reflect a creation myth associated with the surrounding mountain range. The results of this research are regarded as enhancing the cultural significance of this locality.

The rockshelter is relatively long and narrow, and at its maximum it measures 17m wide and 4.5m deep (Figure S1, supplementary information). Our investigation focuses on the southern end where large blocks of roof collapse have created a natural sediment trap. An area measuring 3m x 1.5m was excavated to bedrock, revealing a deposit over 2m deep. Six grid units (see Figure S1) were excavated in 5cm arbitrary layers; however, features were excavated stratigraphically. All excavated sediment was sieved through 6mm and 3mm nested sieves and were subject to flotation and sorting in controlled laboratory conditions.

Seven stratigraphic layers were identified at Djadjiling, forming a sequence of strong brown and reddish-brown sediments (Figure 1 and Figure S2, supplementary information). The stratigraphic layers were defined by subtle changes in sediment colour and matrix composition. The majority of the deposit consists of angular rock fragments produced through physical weathering or exfoliation of the rockshelter roof and walls. The remainder of the deposit is comprised of silt derived through chemical weathering of the bedrock and aeolian deposition. Sediment colour is influenced by the different coloured bands of the Marra Mamba Iron Formation (MacLeod Member), which is very shaly and easily eroded (Blockley *et al.* 1993:54). The proportion of exfoliated roof fall and silt varies throughout the layers, but in general, the proportion of rock increases with depth. The rockshelter is not subject to gully flooding, but it does receive some colluvial wash during extreme rainfall events.

Initial Results

Flaked stone artefacts and hearth features were identified throughout the deposit up to a depth of 165cm below the datum (cmbd). Fourteen *in situ* charcoal samples were selected from features, arbitrary excavation layers, and key stratigraphic changes. The radiocarbon results listed in Table 1 provide a temporal framework for the archaeological sequence and reveal that the site was first occupied c.35,000 BP. Calendar ages are presented in Table 1, calibrated using IntCal09 (Reimer *et al.* 2009) and OxCal v4.1 (Bronk Ramsey 2009). IntCal09 is the first calibration dataset ratified by the ^{14}C community to extend the calibrated timescale back to 50,000 cal BP. This calibration dataset was produced in response to the recent proliferation in use of calibration datasets not officially recognised by the ^{14}C community, but caution is recommended in its use (for a discussion see Reimer *et al.* 2009). We have therefore opted to discuss all dates in the text in non-calibrated ^{14}C years.

To determine the onset of sediment accumulation in the rockshelter, two basal charcoal samples were dated from Layer 7. Samples Wk-23314 (28,461±223 BP) and Wk-23315 (33,584±410 BP) were collected at depths of 170.5cmbd and 193cmbd. These samples were not associated with cultural material, and they were collected more than 10cm and 30cm below the earliest cultural layer respectively. These ages do not fit conformably in the chronological sequence and are argued to be anomalous. The most likely explanation for these anomalous dates is that younger charcoal fell into the trench from exposed section walls during excavation, and it was not recognised as intrusive. The Layer 7 sediment is extremely loose, as it is largely composed of exfoliated rock with a very low proportion of fine sediment.

The earliest evidence of site occupation occurs between 165cmbd and 140cmbd, which correlates approximately

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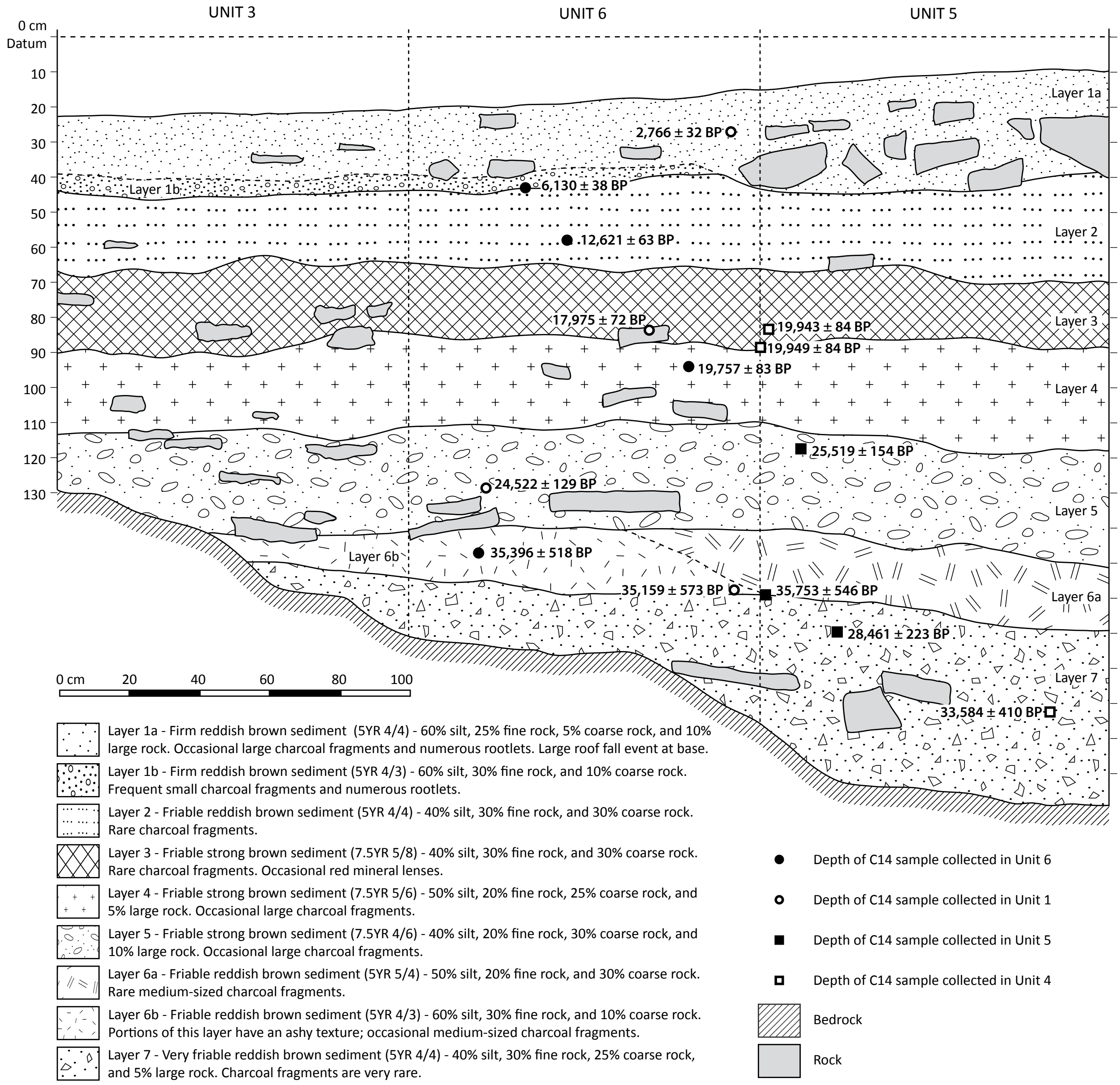

Figure 1 Eastern stratigraphic section of Units 3, 5, and 6, Djadjiling rockshelter. Fine rock (<2 cm), coarse rock (2-10cm), large rock (>10cm).

to stratigraphic Layer 6. Three dates of c.35,000 BP offer stratigraphically sound ages for this layer. Charcoal sample Wk-23312 (35,396±518 BP) was recovered from a small hearth feature, while samples Wk-22787 (35,159±537 BP) and Wk-23313 (35,753±546 BP) were collected during the excavation of arbitrary layers. A total of 664 stone artefacts was recovered from this period, accounting for 50.5% of the total site assemblage (Table S1, supplementary information). Although refitting was not purposefully undertaken during the analysis, at least six sets of conjoining artefacts were identified throughout Layer 6. There is little vertical difference between the conjoined artefacts, suggesting that there is minimal or no disturbance to this deposit.

Following the initial phase of site use, sedimentation rates and artefact discard rates decrease significantly from 140cmbd to 70cmbd, or approximately Layers 5 through 3. Together, these layers represent the period between c.35,000 BP and c.14,000 BP. Charcoal samples bracketing the middle and upper limit of Layer 5 date to c.25,000 BP (Wk-23311 and Wk-22786). Three samples near the contact of Layers 3 and 4 date to c.20,000 BP (Wk-23308, Wk-23309 and Wk-23310), suggesting Layer 4 was deposited between c.25,000 BP and c.20,000 BP. Just above these dates, a radiocarbon determination of 17,975±72 BP (Wk-22785) was obtained for the midpoint of Layer 3. The close spatial relationship of samples Wk-22785 and Wk-23308 suggest either extremely low sedimentation during this period, or a zone of mixing in the deposit. The upper boundary of Layer 3 was not directly dated, but it is estimated to be c.14,000 BP based on an age-depth curve.

These layers show a sudden drop in artefact numbers. In Layer 5 (c.140-115cmbd) and Layer 4 (c.115-90cmbd) 136 and 153 artefacts were recorded respectively. The proportion of artefacts declines further in Layer 3 (c.90-70cmbd), with just 81 artefacts recovered. Layer 3, which was deposited between 20,000 BP and 14,000 BP, represents the lowest phase of artefact discard.

Radiocarbon dates from Layers 2 and 1 offer insight into the terminal Pleistocene and Holocene archaeological sequence. Charcoal collected from the midpoint of Layer 2 yielded an age of 12,621±63 BP (Wk-23307). The transition between Layers

2 and 1 dates to 6130±38 BP (Wk 23306), indicating a mid-Holocene stratigraphic change during which there is an episode of roof collapse. The uppermost age of 2766±32 BP (Wk-22784) was determined from a distinctive, well-preserved late Holocene hearth. A large heat-shattered blade was recovered *in situ* resting on top of this feature, implying that this recent feature is relatively undisturbed.

In general, the artefact discard rates observed in the terminal Pleistocene (Layer 2) and Holocene (Layer 1) sequence are consistent with the pattern demonstrated in Layers 5 and 4. Layer 2 contained 152 flaked stone artefacts, and 129 artefacts were recovered from Layer 1. No backed artefacts or other prominent mid-Holocene stone artefact technologies are present in the assemblage.

Discussion

The Djadjiling radiocarbon ages have implications for our understanding of the archaeology of the Pilbara and greater arid zone. Our excavation results extend the known antiquity of Aboriginal occupation in the Pilbara to c.35,000 BP. Until recently, research suggested the inland Pilbara was settled between c.20,000 BP and c.26,000 BP as reported for the sites of Jundaru, previously known as Malea, 20,360±320 BP (Edwards and Murphy 2003); Newman Orebody XXIX, 20,740±345 BP (Maynard 1980); and Newman rockshelter, 26,300±500 BP (Brown 1987). The evidence from Juukan-1 rockshelter also suggests early occupation of the Pilbara uplands; however, the site requires further investigation, as only one artefact is currently reported beneath a charcoal sample dated to 32,920±270 BP (Slack *et al.* 2009:34). The Djadjiling radiocarbon determinations correspond well with other inland archaeological sequences, such as those reported for Puritjarra and Kulpi Mara rockshelters (Smith *et al.* 1997, 2001; Thorley 1998).

Possibly, the greatest strength of Djadjiling is its comparatively large Pleistocene artefact assemblage, which demonstrates repeated site use c.35,000 years ago. The assemblage also indicates changes in site use over time, particularly during the last glacial maximum (LGM). In northwest Western Australia, the arid conditions of the LGM occurred between c.33/32,000 cal BP to c.20,000 cal BP, followed by a period of climatic instability until c.15/14,000 cal BP with the return of summer precipitation (Van der Kaars *et al.* 2006:888; Williams *et al.* 2009:2410; Wyrwoll and Miller 2001:126). Veth (1993:109) has proposed that the Hamersley Plateau provided refuge during the cold and arid conditions of the LGM, a model supported by evidence from Milly's Cave (Marwick 2002b), as well as Juukan-1 and Juukan-2 (Slack *et al.* 2009). At Djadjiling, intermittent site use is evident throughout this period (see Table 1), further verifying this model.

In summary, Djadjiling rockshelter provides unequivocal evidence for human occupation in the Pilbara from c.35,000 BP, and it demonstrates intermittent site use during the LGM. The sizeable artefact assemblage offers a rare opportunity to explore the technological organisation of late Pleistocene hunter-gatherers. Future research will examine the lithic, floral, and faunal assemblages, as well as the site's palaeoenvironmental record.

Supplementary Information

Supplementary information for this article is available online at www.australianarchaeologicalassociation.com.au.

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Table 1 Radiocarbon ages for Djadjiling rockshelter.

Lab. No.	Method	Unit-Quad	Layer	Depth (cmbd)	Depth (~cmbs)	δ^{13}C‰	F^{14}C%	^{14}C Age (years BP)	Calibrated Age BP (68.2% probability)	Calibrated Age BP (95.4% probability)
Wk-22784	Conv.	U1-QC	1a	27	14.5	-23.4±0.2	70.0±0.3	2766±32	2921-2909 2885-2841 2828-2794	2946-2784
Wk-23306	AMS	U6-QB	1b	43	29	-24.6±0.2	46.6±0.1	6130±38	7156-7112 7068-7056 7028-6947	7160-6928 6921-6912
Wk-23307	AMS	U6-QB	2	58	40	-24.4±0.2	20.8±0.1	12,621±63	15,115-14,789 14,743-14,670	15,222-14,482 14,337-14,256
Wk-22785	AMS	U1-QA	3	83	70.5	-23.6±0.2	10.7±0.1	17,975±72	21,537-21,336	21,705-21,172
Wk-23308	AMS	U4-QB	3	83-85	75	-22.1±0.2	8.4±0.1	19,943±84	23,980-23,625	24,208-23,450
Wk-23309	AMS	U4-QD	3	88-96	80	-23.6±0.2	8.3±0.1	19,949±84	23,991-23,632	24,216-23,457
Wk-23310	AMS	U6-QA	4	94	77.5	-22.0±0.2	8.5±0.1	19,757±83	23,786-23,471	23,921-23,301
Wk-23311	AMS	U5-QB	5	117	104	-21.6±0.2	4.2±0.1	25,519±154	30,562-30,226	30,786-30,161 30,050-29,693
Wk-22786	Conv.	U1-QD	5	128.5	112.5	-22.1±0.2	4.7±0.1	24,522±129	29,532-29,257	29,696-28,798 28,679-28,615
Wk-22787	AMS	U1-QA	6b	148	137	-22.0±0.2	1.3±0.1	35,159±537	40,975-39,613	41,365-38,955
Wk-23312	AMS	U6-QA	6b	157	142.5	-23.3±0.2	1.2±0.1	35,396±518	41,242-40,007	41,576-39,189
Wk-23313	AMS	U5-QB	6a	159	145	-22.8±0.2	1.2±0.1	35,753±546	41,497-40,412	41,901-39,548
Wk-23314	AMS	U5-QB	7	170.5	158.5	-23.2±0.2	2.9±0.1	28,461±223	33,239-32,466	33,451-31,932
Wk-23315	AMS	U4-QA	7	193	180.5	-23.0±0.2	1.5±0.1	33,584±410	38,873-37,704	39,442-37,017

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